DOCUMENT RESUME

ED 315 330 SO 020 430

AUTHOR Brandon, E. P.
TITLE The Deductive Logical Competence of Non-Graduate Caribbean Teachers.
PUB DATE 89
NOTE 35p.
PUB TYPE Reports - Research/Technical (143) -- Statistical Data (110)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Abstract Reasoning; Critical Thinking; *Deduction; Foreign Countries; Higher Education; *Knowledge Level; *Logic; Problem Solving; Statistical Analysis; Teachers; Test Results; Validity
IDENTIFIERS Ennis (Robert); *Jamaica; *Teacher Competencies

ABSTRACT

Data on some aspects of the deductive logical competence of nongraduate teachers in the English-speaking Caribbean, primarily Jamaica, are reported in this document. The teachers sampled were those who sat for entrance examinations for the University of the West Indies (Mona) Faculty of Education Bachelor of Education and Certificate of Education programs from 1985 to 1989. The investigations conducted were based on the extensive work carried out in the United States by Robert Ennis and his associates. Deductive logic studies those situations in which a given set of statements, the premises, necessitates another set, the conclusion; that is, if the premises are true, then the conclusion has to be true also. Six examples of each formally identified logical principle were given to those being tested. Respondents were held to have mastered a principle if they got at least five of the six questions right. Results did not reflect a satisfactory level of elementary reasoning ability. The findings are presented in 11 detailed statistical tables and 3 appendices. An 11-item bibliography is also included. (JB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED315330

The Deductive Logical Competence of Non-Graduate Caribbean Teachers

E.P. Brandon
Dept of Educational Studies
University of the West Indies
Mona
Kingston 7
Jamaica

1989

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

E. P. BRANDON

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SO 020 430

BEST COPY AVAILABLE

The Deductive Logical Competence of Non-graduate Caribbean Teachers

Introduction

This paper reports data on some aspects of the deductive logical competence of non-graduate teachers in the English-speaking Caribbean, primarily Jamaica. It is intended to complement and extend the work reported in Nolan and Brandon [10] on levels of competence among secondary school children in Jamaica on various types of conditional reasoning.

The Sample

The teachers sampled were those who sat entrance examinations for the UWI, Mona, Faculty of Education B.Ed. and Cert. Ed. programmes from 1985 to 1989. These people are teachers who have been trained in regional teacher training colleges and are still working in the school system of their territory. At the time of sitting the examination, the majority are working in the primary sector, though many of those applying for training in specific secondary subjects are already working in the secondary sector, and many successful applicants will return to that sector, or even to teacher training itself.

Given that none of the territories can boast a large graduate teaching force, these applicants are not untypical of teachers in their context, in particular they are fairly representative of the sort of teachers the majority of students are likely to meet. They are perhaps mainly unusual in that they are trying to improve their lot through further teacher training. But while in very general terms the teachers sampled are not unusual, they do not constitute good samples when broken down by such factors as sex. In this particular case, males dominate in administrative positions and are found mostly in the secondary sector, and it is from such backgrounds that the vast majority of the male applicants come. The data are almost certainly skewed also with respect to geographical distribution since rural isolation or sheer distance from the Mona campus is probably enough to deter many teachers. In this respect it should also be noted that the representativeness of these applicants is much stronger for Jamaica than for the other territories whose teachers might in most cases seek to apply to other campuses of the UWI.

Tables 1 and 2 give a breakdown of the five batches of teachers. It is possible that the same person can sit the entrance examination on different occasions, and it is known

Table 1: Applicants, by programme, sex and territory, 1985-89

	1985				1986				1987			
N	622				472				361			
	B.Ed.		Cert.		B.Ed.		Cert.		B.Ed.		Cert.	
N	247		375		179		293		224		137	
	M	F	M	F	M	F	M	F	M	F	M	F
	57	188	67	308	46	132	69	224	43	181	32	105
Anguilla	-	-	-	-	-	-	-	-	1	-	-	-
Antigua	1	-	1	8	-	1	1	8	1	2	1	4
Bahamas	-	1	-	-	-	-	-	-	-	-	-	1
Barbados	-	-	2	9	-	-	4	10	-	-	-	6
Belize	2	2	1	3	3	6	-	1	2	3	1	1
C.O.B.	6	27	-	-	3	18	-	-	3	18	-	-
Dominica	-	-	-	-	-	-	3	12	-	1	2	13
Grenada	1	1	-	-	-	-	-	-	1	2	-	1
Guyana	-	-	-	-	-	-	-	-	-	1	-	-
Jamaica	38	149	46	270	35	98	30	148	31	152	21	69
St Kitts	5	-	-	3	-	-	-	-	-	1	-	-
St Lucia	2	4	7	10	4	2	4	11	2	1	3	5
St Vincent	-	1	-	-	-	-	-	-	1	-	1	-
Trinidad	2	3	10	3	1	7	27	34	1	-	3	5
Other	-	-	-	-	-	-	-	-	-	-	-	-

	1988				1989			
N	594				622			
	B.Ed.		Cert.		B.Ed.		Cert.	
N	389		205		385		237	
	M	F	M	F	M	F	M	F
	84	305	32	173	78	307	37	200
Anguilla	-	-	-	-	-	-	-	-
Antigua	-	-	2	17	-	-	1	34
Bahamas	-	-	-	-	-	-	-	-
Barbados	-	-	1	2	-	2	2	7
Belize	2	1	-	-	3	1	1	1
C.O.B.	5	19	-	-	7	29	-	-
Dominica	-	2	-	7	-	1	1	5
Grenada	-	-	3	4	1	-	1	2
Guyana	-	-	-	-	-	-	-	-
Jamaica	72	276	22	127	63	269	24	139
St Kitts	4	-	-	-	-	-	-	-
St Lucia	1	3	1	15	4	2	3	9
St Vincent	-	-	-	-	-	-	-	-
Trinidad	-	2	3	1	-	3	4	3
Other	-	2	-	-	-	-	-	-

Note: in 1985, two B.Ed. candidates did not give their sex; similarly in 1986, one candidate. C.O.B. stands for the College of the Bahamas; candidates classified as "other" are probably from Turks and Caicos.

Table 2: Applicants, by specific programme, 1985-89

	1985	1986	1987	1988	1989
B.Ed. total	247	179	224	389	385
Administration	-	-	57	111	96
Primary	-	-	58	122	106
English	-	-	23	32	39
Int. Science	-	-	7	13	20
Maths	-	-	16	31	30
Reading	-	-	9	7	10
Soc Studies	-	-	-	21	14
Spanish	-	-	1	1	2
Special Ed.	-	-	23	27	32
C.O.B.	33	22	21	24	36
Cert. Ed. total	375	293	137	205	237
Administration	-	-	9	55	18
English	53	35	22	27	29
Int. Science	40	33	11	7	22
Maths	59	62	30	40	46
Reading	200	134	56	52	83
Religious Ed.	-	15	4	3	5
Soc Studies	20	11	5	20	33
Spanish	3	3	-	1	1

Note: B.Ed. candidates were not classified by specialization until 1987.

that several of those persons applying to study B.Ed. special subjects had already taken the examination when previously applying for the Certificate programme. No attempt has been made to identify such repeaters.

In the course of this report mention will sometimes be made of other related investigations. These include groups of Jamaican school children who were given versions of the tests used in the entrance examination and also similar groups and a group of teacher trainees in St Lucia who were given a test which was mostly concerned with different principles.

Principles of Deductive Logic

Deductive logic studies those situations, typically but not only in a context of argument, in which a given set of statements (possibly empty), the premises, necessitates

another set, the conclusion, that is to say, if the premises were true then the conclusion would have to be true too. An argument in which this happens (or more generally, the inference in any such case) is labelled valid. Very many such situations depend only on the structure of the statements involved and not upon their semantic content, so that deductive logic can be studied as a matter of form: the argument every A is a B, x is an A, so x is a B is deductively valid, no matter what one is talking about (humans, mortality and Socrates in the stock example, or equally well whales, mammals, and the whale stranded on your local beach). Just as one can identify valid forms of argument so one can pick out argument structures that do not fit the criterion (in which the premises could all be true while the conclusion is false), although they might seem to be valid. Such structures are deductively invalid arguments; many of what are called fallacies exemplify such deductively invalid principles of reasoning.

The investigations reported here have been based on the extensive work carried out in the US by Robert Ennis and his associates on competence in simple deductive logic (Ennis and Paulus [5]). In particular their approach to the identification of distinct principles of valid or invalid argument has been retained. The example of valid argument given in the previous paragraph would then count as one (symbolically expressed) case of a particular principle, other cases being given by replacing the symbols with words uniformly through the argument.

In Ennis' tests, and in these investigations, six examples of each such formally identified logical principle are given. Respondents are held to have mastered a principle if they get at least five of these questions right; they are considered on the borderline if they get exactly four of them right. It should be noted that on this approach a person may be considered to have mastered a valid principle, say, even though he has not grasped how it differs from a similar but invalid one. As has been noted elsewhere (Brandon [2]), a stricter view would drastically cut the number of persons who could be regarded as having mastered any logical principle at all.[1]

Logical principles can be grouped in various ways. The first and crucial criterion is validity or invalidity. The other main way is by reference to their major structural components. Thus one can distinguish various principles focussing on conditional statements (such as all the principles used in Nolan's pioneering work in Jamaica, Nolan [9], and in the report mentioned above, Nolan and Brandon [10]) or quantifiers (words for how many, all, some, most, etc.) or disjunctive statements, and so on.

An interesting and unusual feature of the investigations reported here is that two principles involving the plurative or pleonetetic (Geach's terms [6]) quantifier most have often been used. This quantifier is not normally studied in elementary formal logic, even though its meaning is perhaps closer to what we often intend in using plurals or the universal quantifier all than how that universal quantifier is itself construed in formal logic (cf. Hodges [7], p. 196).

A couple of other "principles" have been used in the investigations, although they do not fit the characterization given above. One such was a set of items depending on general properties of relational expressions, the other on simple mathematical relationships. In both cases, the set of six items was composed of three valid cases and three invalid, so these "principles" have been treated very differently from the rest.

The Instruments

Each entrance examination has contained a paper with a section consisting of 36 items in the standard Ennis format: suppose you know that .... then would it be true that ....? Three possible answers are offered: Yes, glossed as it must be true, given what you are told; No, it can't be true, given what you are told; and Maybe, it may be true or it may be false, you haven't been told enough to be certain whether it is Yes or No.

In this format, the correct answer for all invalid principles is Maybe. A few, perhaps over-cautious respondents give this answer to virtually all questions, and so automatically tend to achieve mastery of invalid principles. A related quibble with the format is that one's immediate reaction to an invalid principle might be "no", meaning "not necessarily." It is difficult to check whether in fact this has had any serious impact on the results. The detailed item analyses given in the Appendices suggest that there may be some such effect since 1986 as the numbers giving the answer "No" to questions using invalid principles where the expected incorrect answer is "Yes" are much higher than those answering "Yes" where the expected incorrect answer is "No" (compare q3, q7, q17 with q12 and q20). But on valid principles too there are often large numbers offering the unexpected wrong answer.

As noted already, the 36 items are grouped into six principles of six items each. Table 3 lists the principles employed in the five tests and gives the formal structure for each principle.

Table 3: Principles Tested in Each Test

1985 [Mona Test B(E)]	MODPON	MODTOL	HYPSYL	DENCON	AFFCON	QAFCON
1986 [Test C(E)]	REL*	MODTOL	MVAL	DENANT	NUM*	MINVAL
1987/89 [Test C(E)2]	MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL

* These "principles" consist of three valid and three invalid items each and are not identified in a purely formal manner. The other principles are formally as follows:

MODPON - [valid] if p then q, p, so q

MODTOL - [valid] if p then q, not q, so not p

HYPSYL - [valid] all A are B, all B are C, so all A are C

DENCON - [valid] all A are B, this is not B, so this is not A

DENANT - [invalid] if p then q, not p, so not q

AFFCON - [invalid] if p then q, q, so p

QAFCON - [invalid] all A are B, this is B, so this is A

MVAL - [valid] most A are B, all B are C, so most A are C

MINVAL - [invalid] most A are B, most B are C, so most A are C.

The three valid REL items will be labelled RV; they are based on the transitivity of certain relations. The three invalid REL items will be labelled RI. Similarly the NUM items will be divided into MATHV (or MV) and MATHIN (or MI). As noted later in the text, items in 1985 were also classified into symbolic (SYMBOL or SYM) and suggestive (SUG) groups.

As should be obvious from the preceding, the items used to test a principle have been identified structurally (or semantically for the two deviant principles). No suggestion is involved that any ordinary person would respond to such structure, although one might hope that a student of formal logic would do so. One could say that the items have been chosen normatively, from the perspective of formal logic, rather than with an eye to uncovering the ways in which untutored people handle such problems.[2] There is then no particular interest or importance in conventional measures of reliability for such tests; they indicate rather the extent to which people fail to utilize what might seem the most appropriate way of handling these problems. The Appendices contain relevant statistics for these tests, from which it

can be seen that the Cronbach alphas are just about respectable, though this is due more to the number of items (and in 1985 to the greater variance of the scale due to the many who left several questions unanswered) than to any uniformity in content, as the item to scale correlations suggest. It can also be seen that such correlations tend to improve as one proceeds through the test, which again is simply a reflection of the numbers failing to finish in good time.

Each entrance examination paper also contains two other tests, one verbal (as a matter of fact, since 1986 this has involved a grasp of relations between pairs of items so is more than a test of vocabulary), the other usually of spatial ability, but in 1989 of simple applied mathematics. Candidates are told to spend half an hour on each of the three sections, but this does not always happen. The logic questions are in the third section of the paper, with the result that latecomers often omit most or all of them. For that reason, sample numbers are a little smaller than the number of actual entrants since persons failing to answer more than a couple of questions in the logic test have been excluded. Control over examination conditions was worst in 1985 - 47 entrants have been excluded and the item analyses reported in Appendix 1 show that well over 100 candidates failed to answer the last 15 questions; results will occasionally be given for 1985 based on a much smaller group of 452 who were deemed to have completed the test. But for those included in the sample, missing answers have been regarded as mistakes.

The complete entrance examination comprises another two papers for all candidates except those for the College of the Bahamas. Paper 2 is an English language paper; paper 3 was a general education paper but now relates to the specific area the candidate wishes to pursue. These papers vary considerably from year to year; results on paper 2 will be given to allow comparisons with the verbal test included in paper 1.

Results

The most important result from these tests is the percentage mastery of each of the logical principles. Table 4 gives the percentage of those who have mastered and are on the borderline for each principle in each test. The percentage of those lacking mastery is easily calculated.

The stability of mastery percentages is noticeable, with 1986 being a little better than the rest for valid principles. This stability might seem upset by the results for 1985 but when the smaller group of 452 "finishers" is

Table 4: Percentage Mastery and Borderline for Principles

1985 (N = 622)

	MODPON	MODTOL	HYPSYL	DENCON	AFFCON	QAFCON	(SYM	SUG)
Mastery	41	27	55	36	2	5	7	9
Borderline	21	18	20	24	4	6	20	29

1986 (N = 472)

	REL*	MODTOL	MVAL	DENANT	NUM*	MINVAL	(RV	RI	MV	MI)
Mastery	30	49	60	5	35	8	45	7	25	35
Borderline	28	20	24	8	31	8	38	42	39	40

1987 (N = 361)

	MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL	(MV	MI)
Mastery	66	38	58	5	33	9	18	38
Borderline	15	20	22	12	24	11	39	37

1988 (N = 594)

	MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL	(MV	MI)
Mastery	67	42	57	4	27	9	17	34
Borderline	17	21	21	9	31	9	42	41

1989 (N = 622)

	MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL	(MV	MI)
Mastery	68	44	57	6	31	13	23	34
Borderline	18	22	21	9	24	9	32	37

used that year falls into line (with, for instance, scores of 53 and 25 for MODPON, and 37 and 23 for MODTOL).

The relative difficulty of the principles also remains stable, and is consistent with Ennis' findings for the US. The valid principles are ordered HYPSYL, MODPON, MVAL, DENCON and MODTOL where principles using quantifiers are easier than their conditional analogues. This is also found with the invalid principles QAFCON and AFFCON while the quantifier

principle MINVAL is easier than DENANT though it has no obvious formal analogy with it.

While the results are fairly stable and in accordance with expectations perhaps the most important point to be made about them is that they do not reflect a satisfactory level of elementary reasoning ability. They tell us that roughly 40% of the entrants have not mastered MODTOL, which is a fundamental reasoning tool in our investigation of the world: a long tradition, stretching at least from Lord Bacon to its most notorious contemporary exponent, Sir Karl Popper, has seen in the falsification of predictions the most powerful means we have of revising our view of the world (cf. Brandon [3], ch. 3). When this is combined with the gross inability (characterizing roughly 80% of the entrants) to recognize invalid inferences (which is to say, a liability to think one is on safe ground when one isn't), one might be forgiven for refusing to place much confidence in the role of reason in the mental economy of these teachers.

While mastery of formally invalid principles is extremely low (as it is in Ennis' US data too) it is worth noting that the respondents do considerably better with invalid items where the invalidity is more a matter of content (those items labelled RI and MI); indeed with the particular items selected here they do better on invalid items with a mathematical content than on valid ones. This may support attempts to excuse the performance on the formal principles by reference to contextual factors (cf. Brandon [1]) or in other ways, though whatever one says, the answers given by the vast majority are still wrong and reflect an inadequacy somewhere in their processing of the information given.

It is possible to inquire whether there are any interesting variations among the entrants on logical competence. But as noted earlier, such investigations can only be regarded as provisional and suggestive, given the nature of the sample. Comments will be made about variations in deductive competence between students applying for different programmes, from different territories, and finally of different gender.

Table 5 gives the mean and standard deviation of scores (with F values) on each principle and of various other variables for three groups of applicants distinguishable in terms of academic programme. Three groups are produced since Certificate applicants can be separated into those applying for the intramural programme at Mona and those applying to take the in-service programme offered on the UWI Distance Teaching Experiment's telephonic system. Anecdotal evidence suggested that these two groups might differ, as indeed table 5 confirms. It may be added that the UWIDITE applicants include virtually all the non-Jamaican Certificate

applicants, though also a good proportion of Jamaican applicants as well.

Table 5: Means, Standard Deviations and F test for Variables by Programme

1985

		MODPON	MODTOL	HYPSYL	DENCON	AFFCON	QAFCON
B.Ed.	mean	3.75	3.30	4.27	3.87	1.31	1.51
N = 247	s.d.	1.72	1.60	1.46	1.46	1.30	1.47
Cert.	mean	3.86	3.16	4.39	3.64	1.14	1.51
N = 160	s.d.	1.61	1.61	1.44	1.36	1.14	1.33
DTE	mean	3.95	3.39	4.43	3.93	1.34	1.72
N = 215	s.d.	1.72	1.62	1.52	1.46	1.19	1.55
	F	0.77	0.88	0.77	2.04	1.43	1.41
	p	0.46	0.41	0.46	0.13	0.24	0.24

		LOGTOT	VERTOT	SPATOT	SYMBOL	SUGG
B.Ed.	mean	18.00	42.25	33.58	2.51	2.95
N = 247	s.d.	6.48	12.80	16.12	1.43	1.34
Cert.	mean	17.69	40.83	25.97	2.49	2.82
N = 160	s.d.	5.80	11.13	13.71	1.37	1.28
DTE	mean	18.76	42.91	30.61	2.73	3.04
N = 215	s.d.	6.46	12.58	14.90	1.42	1.32
	F	1.48	1.34	12.26	1.73	1.25
	p	0.23	0.26	0.00	0.18	0.29

1986

		REL*	MODTOL	MVAL	DENANT	NUM*	MINVAL	RV	RI
B.Ed.	mean	3.75	4.35	4.69	1.54	3.81	1.74	2.30	1.45
N = 179	s.d.	1.25	1.40	1.25	1.51	1.37	1.89	0.79	0.83
Cert.	mean	3.15	4.05	4.43	1.40	3.69	1.54	1.98	1.18
N = 124	s.d.	1.21	1.49	1.25	1.40	1.36	1.71	0.88	0.76
DTE	mean	4.00	4.12	4.76	1.73	4.08	1.47	2.41	1.59
N = 169	s.d.	1.15	1.55	1.24	1.56	1.25	1.58	0.70	0.80
	F	18.15	1.78	2.66	1.78	3.42	1.12	11.14	9.40
	p	0.00	0.17	0.07	0.17	0.03	0.33	0.00	0.00

		MATHV	MATHIN	LOGTOT	SPATOT	VERTOT	PAPER2
B.Ed.	mean	1.74	2.07	19.88	21.66	29.49	28.68
N = 179	s.d.	0.85	0.95	4.91	8.23	8.52	13.54
Cert.	mean	1.73	1.96	18.27	18.36	25.86	24.19
N = 124	s.d.	0.87	0.90	4.42	6.63	8.31	9.94
DTE	mean	2.03	2.05	20.15	22.19	30.37	27.42
N = 169	s.d.	0.82	0.83	4.47	8.01	8.55	12.39
	F	6.54	0.59	6.57	9.75	10.87	5.00
	p	0.00	0.55	0.00	0.00	0.00	0.01

1987

		MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL
B.Ed.	mean	4.72	3.86	4.62	1.75	3.68	1.69
N = 224	s.d.	1.32	1.55	1.21	1.64	1.28	1.78
Cert.	mean	4.49	3.51	4.28	1.41	3.46	1.83
N = 76	s.d.	1.60	1.61	1.44	1.33	1.57	1.58
DTE	mean	4.77	3.67	4.51	1.74	4.00	1.80
N = 61	s.d.	1.54	1.79	1.34	1.50	1.46	1.97
	F	0.92	1.42	1.98	1.39	2.58	0.23
	p	0.40	0.24	0.14	0.25	0.08	0.79

		MATHV	MATHIN	LOGTOT	SPATOT	VERTOT	PAPER2
B.Ed.	mean	1.59	2.09	20.32	21.43	27.40	6.81
N = 224	s.d.	0.92	0.90	4.11	8.13	7.65	5.59
Cert.	mean	1.47	1.99	18.97	20.78	22.20	5.63
N = 76	s.d.	0.87	0.98	5.00	7.42	6.86	4.99
DTE	mean	1.98	2.02	20.49	20.80	27.57	7.74
N = 61	s.d.	0.91	0.95	5.06	8.96	7.81	6.13
	F	5.91	0.41	2.86	0.26	14.46	2.48
	p	0.00	0.66	0.06	0.77	0.00	0.09

1988

		MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL
B.Ed.	mean	4.84	3.97	4.52	1.60	3.57	1.68
N = 389	s.d.	1.25	1.54	1.26	1.54	1.37	1.71
Cert.	mean	4.63	3.83	4.34	1.24	3.69	1.82
N = 117	s.d.	1.37	1.61	1.42	1.33	1.31	1.74
DTE	mean	4.86	4.00	4.41	1.63	3.85	1.90
N = 87	s.d.	1.31	1.65	1.49	1.58	1.43	1.70
	F	1.31	0.42	0.95	2.87	1.59	0.76
	p	0.27	0.67	0.39	0.06	0.21	0.47

		MATHV	MATHIN	LOGTOT	SPATOT	VERTOT	PAPER2
B.Ed.	mean	1.60	1.97	20.18	19.42	28.67	10.52
N = 389	s.d.	0.89	0.95	4.44	7.29	8.19	5.81
Cert.	mean	1.64	2.04	19.54	18.30	26.30	9.86
N = 117	s.d.	0.86	0.83	4.59	5.67	8.23	6.40
DTE	mean	1.85	2.00	20.66	21.46	29.41	12.91
N = 87	s.d.	0.85	0.91	5.42	8.41	9.67	6.24
	F	2.91	0.27	1.53	4.89	4.44	7.09
	p	0.06	0.76	0.22	0.01	0.01	0.00

1989

		MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL
B.Ed.	mean	4.91	3.96	4.50	1.63	3.71	2.03
N = 385	s.d.	1.20	1.59	1.29	1.62	1.43	1.93
Cert.	mean	4.58	3.94	4.34	1.47	3.33	1.66
N = 107	s.d.	1.36	1.60	1.37	1.61	1.37	1.65
DTE	mean	5.02	4.18	4.65	1.46	3.64	1.71
N = 130	s.d.	1.29	1.56	1.31	1.55	1.50	1.80
	F	4.00	1.03	1.64	0.78	2.93	2.50
	p	0.02	0.36	0.19	0.46	0.05	0.08

		MATHV	MATHIN	LOGTOT	MATHOT	VERTOT	PAPER2
B.Ed.	mean	1.68	2.03	20.76	15.50	29.90	35.70
N = 385	s.d.	0.93	0.96	4.91	5.06	8.57	10.92
Cert.	mean	1.55	1.78	19.32	14.57	30.01	33.49
N = 107	s.d.	1.03	0.95	4.73	4.66	8.92	12.29
DTE	mean	1.78	1.85	20.65	15.70	30.72	35.90
N = 130	s.d.	0.95	0.95	5.39	5.33	9.62	12.10
	F	1.76	3.79	3.56	1.74	0.42	1.74
	p	0.17	0.02	0.03	0.18	0.66	0.18

The general picture given by table 5 is that the B.Ed. mean score lies somewhere between that for the Mona Certificate and the UWIDITE Certificate applicants. In most cases the actual differences are insignificant (though no test has been done on the persistent ranking of the three groups) and the larger differences are mostly localized to non-formal logical matters (RV, RI, and MATHV in 1986; MATHV in 1987 and almost in 1988; and MATHIN in 1989) or other variables (spatial ability in 1985, 1986, and 1988; verbal in 1986, 1987, and 1988 and the related English paper 2 in 1986 and 1988). The low scores of Mona Certificate applicants in these areas could reflect their provenance predominantly in the Jamaican primary sector, whereas the other two programmes recruit a good number from outside Jamaica and/or the non-primary sector.

Only in the 1989 test was a difference significant at 0.05 found in any of the purely formal logical principles (MODPON) and this appears to have helped the overall logic total to show a significant difference too (though with the B.Ed. mean marginally above the UWIDITE). But with the number of tests reported in table 5 this does not seem particularly important.

It has been suggested that the small but persistent differences found in the two Certificate groups may be related to the territorial origin of the applicants. Because numbers of non-Jamaicans are always very small the data have not been reported by territory, but the 1987 entrants have been divided *a priori* (that is to say, on the basis of impressionistic evidence rather than an examination of actual mean scores for the territories) into two groups, one comprising those from Jamaica, the Bahamas, Dominica, and Grenada, the other comprising the rest. This very crude division produced significant differences on the overall logic total ($p = 0.03$), the principles DENANT ($p = 0.03$) and

MATHV (p = 0.00), and both the verbal test (p = 0.00) and the English paper 2 (p = 0.00). A three-way ANOVA (adding sex as well) on the verbal test (which had shown significant differences by academic programme) gave an F for programme of 15.49 (p = 0.00); for territory of 12.46 (p = 0.00); and for sex of 2.49 (p = 0.12). The biggest difference (on paper 2 where the mainly Jamaican group's mean was 6.16 (s.d. = 5.05) as against 10.54 (s.d. = 7.42) for the others) showed a significant sex/programme interaction (F = 4.23, p = 0.02) but only territory among the main effects, (F = 24.75, p = 0.00). These findings would suggest, if they can be used as a basis for generalization, that while territorial differences are playing a role, there are genuine differences also among the programmes in at least some variables.

While not reported here in detail, territorial means were also calculated for 1988 and 1989; they showed as above larger differences on the non-logical variables: in 1988, the verbal test mean ranged from 21.00 to 38.33; spatial from 15.75 to 30.00; paper 2 from 8.50 to 21.67, while the logic total ranged only from 17.33 to 28.00, valid items from 13.50 to 17.67, and invalid items from 3.83 to 10.33. In 1989 the verbal test ranged from 24.81 to 35.00; maths from 11.67 to 17.14; paper 2 from 32.19 to 47.80; logic total from 18.11 to 24.22, valid items from 13.25 to 17.64, and invalid items from 4.67 to 7.25.

Finally, and possibly most contentiously, it is possible to group respondents with respect to gender. Table 6 reports means, standard deviations, and T values for the various variables grouped by gender (male coded 1, female 2). As noted earlier, there is little likelihood that the gender sampling is as representative as the overall sampling of non-graduate teachers; males are mostly applying for administration, or certain secondary subject specialisms, and this reflects their original position within the school system.

Table 6: Means, Standard Deviations and T-test for Variables by Sex

1985 (N male = 124; female = 496)

		MODPON	MODTOL	HYPSYL	DENCON	AFFCON	QAFCON
Male	mean	3.66	3.18	4.15	3.77	1.40	1.67
	s.d.	1.67	1.48	1.60	1.42	1.34	1.48
Female	mean	3.90	3.33	4.41	3.85	1.25	1.56
	s.d.	1.70	1.64	1.44	1.44	1.20	1.46
	T (618)	-1.41	-0.92	-1.71	-0.50	1.24	0.74
	p	0.16	0.36	0.09	0.62	0.21	0.46

		LOGTOT	VERTOT	SPATOT	SYMBOL	SUGG
Male	mean	17.84	43.04	32.73	2.62	2.84
	s.d.	6.60	11.00	16.85	1.45	1.30
Female	mean	18.29	41.86	29.99	2.57	2.98
	s.d.	6.24	12.66	14.93	1.41	1.32
	T (618)	-0.72	0.95	1.78	0.34	-1.07
	P	0.47	0.34	0.08	0.73	0.29

1986 (N male = 115; female = 356)

		REL*	MODTOL	MVAL	DENANT	NUM*	MINVAL	RV	RI
Male	mean	4.13	4.23	4.83	1.93	4.17	1.76	2.57	1.57
	s.d.	1.12	1.55	1.11	1.69	1.35	1.93	0.61	0.81
Female	mean	3.54	4.17	4.60	1.46	3.79	1.54	2.15	1.38
	s.d.	1.25	1.46	1.28	1.42	1.31	1.67	0.83	0.82
	T (469)	4.51	0.38	1.70	2.95	2.73	1.18	4.90	2.05
	P	0.00	0.70	0.09	0.00	0.01	0.24	0.00	0.04

		MATHV	MATHIN	LOGTOT	SPATOT	VERTOT	PAPER2
Male	mean	2.06	2.11	21.05	23.16	30.82	27.14
	s.d.	0.84	0.89	4.97	8.97	8.46	12.95
Female	mean	1.78	2.01	19.09	20.27	28.22	27.08
	s.d.	0.85	0.89	4.49	7.42	8.66	12.17
	T (469)	3.14	1.06	3.96	3.44	2.80	0.04
	P	0.00	0.29	0.00	0.00	0.01	0.97

1987 (N male = 75; female = 286)

		MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL
Male	mean	4.64	3.47	4.48	1.93	3.95	1.95
	s.d.	1.35	1.66	1.23	1.56	1.48	1.81
Female	mean	4.69	3.83	4.54	1.60	3.62	1.68
	s.d.	1.44	1.59	1.31	1.55	1.36	1.76
	T (359)	-0.28	-1.75	-0.35	1.62	1.80	1.15
	P	0.78	0.08	0.73	0.11	0.07	0.25

		MATHV	MATHIN	LOGTOT	SPATOT	VERTOT	PAPER2
Male	mean	1.73	2.21	20.41	24.07	27.59	6.83
	s.d.	0.93	1.04	4.73	9.55	8.21	5.03
Female	mean	1.61	2.01	19.97	20.43	26.01	6.69
	s.d.	0.92	0.89	4.45	7.55	7.68	5.75
	T (359)	1.05	1.67	0.75	3.49	1.56	0.18
	P	0.30	0.10	0.45	0.00	0.12	0.85

1988 (N male = 116; female = 478)

		MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL
Male	mean	4.52	3.52	4.48	1.98	3.88	1.87
	s.d.	1.45	1.63	1.39	1.61	1.23	1.87
Female	mean	4.87	4.05	4.47	1.43	3.58	1.71
	s.d.	1.24	1.54	1.31	1.47	1.40	1.68
	T (592)	-2.64	-3.33	0.12	3.58	2.15	0.93
	P	0.01	0.00	0.91	0.00	0.03	0.35

		MATHV	MATHIN	LOGTOT	SPATOT	VERTOT	PAPER2
Male	mean	1.84	2.03	20.25	21.77	29.03	11.50
	s.d.	0.88	0.86	5.37	8.29	8.47	6.08
Female	mean	1.60	1.98	20.09	18.95	28.13	10.55
	s.d.	0.88	0.94	4.44	6.85	8.49	6.05
	T (592)	2.74	0.58	0.33	3.81	1.02	1.51
	P	0.01	0.56	0.74	0.00	0.31	0.13

1989 (N male = 115; female = 507)

		MODPON	MODTOL	MVAL	DENANT	NUM*	MINVAL
Male	mean	4.82	3.95	4.43	1.84	4.00	2.21
	s.d.	1.32	1.69	1.45	1.73	1.58	1.96
Female	mean	4.89	4.02	4.52	1.51	3.55	1.83
	s.d.	1.24	1.56	1.28	1.57	1.40	1.84
	T (620)	-0.59	-0.43	-0.64	2.04	3.06	1.97
	P	0.56	0.67	0.53	0.04	0.00	0.05

		MATHV	MATHIN	MATHOT	LOGTOT	VERTOT	PAPER2
Male	mean	1.97	2.03	18.90	21.25	32.04	36.87
	s.d.	0.98	1.01	5.14	5.91	8.15	11.71
Female	mean	1.61	1.93	14.58	20.31	29.65	35.01
	s.d.	0.94	0.95	4.70	4.77	8.97	11.40
	T (620)	3.70	0.94	8.73	1.82	2.63	1.57
	p	0.00	0.35	0.00	0.07	0.01	0.12

As far as the purely logical principles go, table 6 reveals virtually no significant differences, except that DENANT goes to the men on three occasions, while the usual female superiority on MODPON and MODTOL is significant in one year. There are, however, several occasions when the male average is significantly higher on the content-based "principles", REL (both RV and RI) and MATHV, on the spatial and mathematical tests, and on the English paper 2. This superiority in English and mathematical tests probably reflects the skewing of the male sample towards higher status parts of the school system.

Grouping together valid and invalid items allows one a simple view of the very great difference in competence which has been found in all such investigations. Table 7 reports means and standard deviations for valid and invalid items by sex, with T values, allowing a fairly strong test of the suggestion made in Nolan and Brandon [10] that there might be a slight gender-related difference here. As can be seen, the evidence of these data does give prima facie support for such a difference. In only one year is there a significant difference on valid items and the slight advantage varies between male and female from year to year, but in four out of five years there is a significant difference on the invalid items where the male group consistently scores higher. But what in fact does this prove? Table 4 shows conclusively that neither gender comes anywhere near general mastery of invalid principles; it could be argued that table 7 simply displays a slightly greater tendency to hedge one's bets (by answering "MAYBE"), which could be a consequence of slightly higher status and the self-confidence it gives.

Table 7: Means and Standard Deviations for Valid/Invalid Items by Sex

		Valid			Invalid		
		Male		Female	Male		Female
1985	mean	14.77		15.48	3.07		2.81
	s.d.	5.21		5.18	2.48		2.30
	T (618)		-1.38			1.11	
	p		0.17			0.27	
1986	mean	13.69		12.70	7.37		6.39
	s.d.	2.71		2.97	3.55		2.84
	T (469)		3.17			3.02	
	p		0.00			0.00	
1987	mean	14.32		14.67	6.09		5.30
	s.d.	3.67		3.81	3.11		2.64
	T (359)		-0.71			2.22	
	p		0.48			0.03	
1988	mean	14.36		14.98	5.89		5.11
	s.d.	3.97		3.47	2.97		2.76
	T (592)		-1.68			2.68	
	p		0.09			0.01	
1989	mean	15.17		15.05	6.08		5.27
	s.d.	4.24		3.64	3.22		2.95
	T (620)		0.31			2.61	
	p		0.76			0.01	

Besides inquiring about differences among the candidates, one can also ask about differences among the items in the tests. Ennis had attempted to gauge the importance of various content factors on competence in deductive reasoning. He had distinguished items with symbolic content (schematic letters replacing nouns), items with what he called suggestive content (typically arguments with absurd claims in which the conclusion is patently false), and items with ordinary unexceptionable content. The 1985 logic test retained his types of item (with the rest classified as ordinary); it revealed, as expected from Ennis' own work, that these kinds of content do not appear to make much difference overall, although symbolic items do seem somewhat more difficult (see table 8) and are more often omitted (see Appendix 1 in particular). Anecdotal evidence from teaching formal logic suggests that the kind of symbolism also makes a difference. In the entrance examination logic tests, nouns are replaced by schematic letters (so one might be told that there is an X) but in another investigation one of the items for the principle MODPON involved the replacement of whole sentences (or clauses) with schematic letters (e.g. if p then

Table 8: Percentage Mastery and F test on Kinds of Content (1985, N = 452)

	SYMBOL	SUGGESTIVE	ORDINARY
Mastery	9	12	15
Borderline	24	38	38
Mean	2.93	3.36	3.62
Standard Deviation	1.26	1.17	0.83

q) as is done in formal logic. As expected, this item proved much more difficult than the noun replacement equivalent, as shown in table 9.

Table 9: Difficulty and Discrimination Indices for Symbolic Items among two samples

	St Lucia Trainees		Jamaica Grade 10	
	Diff.	Disc.	Diff.	Disc.
Noun variable	.91	.13	.87	.41
Sentence variable	.53	.13	.48	.35

Note: The argument principle is MODPON, in one case phrased as if there is an X, there is a Y, etc. in the other if p then q, etc. The difficulty index is as usual really a facility index - 91% of the trainees got the name variable question right. Unpublished data.

While in general types of content do not play a very important part, the specific content of individual items may well make a big difference to performance. This possibility is consistent with the suggestion that people in general do not attend to, or at least directly base their judgment upon an informed awareness of, the formal structure of an argument or inference when they evaluate it. In any case, the difficulty (or better facility) and discrimination indices for the individual items reveal considerable variation within each formally identical principle, as can be seen from the appendices. The difficulty index is the mean right score for the item; the discrimination index used is the difficulty in the bottom 27% subtracted from the difficulty in the top 27% of the sample. In most years the most consistent set of items is MINVAL, where there are no distractions provided by logically superfluous and unexpected negations in any of the items.

The 1985 test was structured to examine the relationship between items expressed using conditionals and virtually identical items expressed with quantifiers. In modern formal logic the quantified expressions are in fact seen as containing conditionals, so all A are B is construed as for all x, if x is A then x is B. The questions testing MODTOL were paired with those for DENCON while three of those for AFFCON were paired with QAFCON. Table 10 gives mean scores and inter-item correlations on these sets of items. While the inter-item correlations are not particularly impressive, they are higher than such correlations between unpaired items, even within the same principle: the virtual identity of content seems to be playing a role, whereas the structural parallels exploited by the theory of modern logic do not seem to impinge.

Table 10: Mean scores and inter-item correlations on paired items

MODTOL		DENCON		corr	AFFCON		QAFCON		corr
	mean		mean			mean		mean	
q2	.83	q35	.64	.16	q5	.30	q11	.42	.37
q10	.43	q26	.37	.31	q9	.15	q33	.12	.17
q17	.44	q20	.48	.26	q22	.12	q15	.20	.12
q23	.51	q14	.65	.36					
q28	.60	q7	.90	.12					
q32	.46	q4	.76	.20					

When responses are classified by reference to the correct answer and to the formal principle involved, performance seems to involve a number of components. We have already noted the probable importance of the specific content; correlations between the formally identifed principles usually show a strong linkage between valid principles and a weaker one between invalid principles but very little across that divide (though DENANT is often negatively correlated with valid conditional principles). In those tests in which numeric arguments were used, these items generally stood out on their own as well.

To try to obtain a rough picture of what might be behind the data, exploratory factor analysis of the correlations between the logical principles, other variables, and sex (as a further check on the role of gender in reasoning ability) was attempted. Table 11 gives for each year the correlation matrix and a varimax rotated factor analysis for each matrix, using estimated communalities on the diagonal and including factors with an eigenvalue of at least 1 or factors explaining a substantial amount of the variance.

Table 11: Correlation Matrices and Factor Analyses for each sample for logical principles, other tests, and sex

1985

(a) Correlation matrix

	modp	modt	hyps	denc	aff	qaf	ltot	stot	vtot
sex	.07	.05	.07	.03	-.03	-.02	.04	-.09	-.04
modpon		.58	.63	.57	.12	.25	.78	.14	.18
modtol			.54	.66	.18	.27	.79	.21	.24
hypsyl				.58	.22	.27	.78	.17	.26
dencon					.18	.27	.78	.19	.24
affcon						.51	.48	.10	.13
qafcon							.59	.21	.26
logtot								.24	.31
spatot									.39
vertot									1.00

(b) Varimax rotated factor analysis (2 factors, eigenvalues 2.74 and 0.68 explaining 72.0% and 17.8% of variance respectively) of (a) omitting logtot

	Factor 1	Factor 2
sex	.10	-.11
modpon	.75 *	.13
modtol	.73 *	.22
hypsyl	.71 *	.23
dencon	.74 *	.21
affcon	.09	.53 *
qafcon	.19	.61 *
spatot	.15	.38 *
vertot	.21	.41 *

1986

(a) Correlation matrix

	pap2	rv	ri	modt	mval	den	minv	mv	mi	ltot	stot	vtot
sex	.01	-.22	-.10	-.01	-.06	-.12	-.05	-.12	-.04	-.16	-.16	-.12
paper2		.11	.07	.13	.22	.06	-.03	.07	.12	.17	.17	.35
rv			.18	.25	.35	.15	.07	.19	.13	.51	.26	.32
ri				.20	.18	.08	.08	.12	.16	.43	.17	.18
modtol					.35	-.18	.04	.10	.24	.51	.16	.27
mval						.06	.03	.19	.30	.59	.25	.36
denant							.18	.14	.11	.43	.13	.19
minval								.10	.21	.53	.15	.08
mathv									.16	.43	.18	.28
mathin										.54	.11	.24
logtot											.34	.45
spatot												.42
vertot												1.00

(b) Varimax rotated factor analysis (2 factors, eigenvalues 2.12 and 0.53 explaining 66.0% and 16.6% of variance respectively) of (a) omitting logtot

	Factor 1	Factor 2
sex	-.09	-.29
paper2	.35 *	.06
rv	.43 *	.28
ri	.30 *	.15
modtol	.56 *	-.14
mval	.60 *	.09
denant	.01	.48 *
minval	.06	.30 *
mathv	.26	.29
mathin	.37 *	.15
spatot	.57 *	.33 *
vertot	.37 *	.15

1987

(a) Correlation matrix

	pap2	modp	modt	mval	den	minv	mv	mi	ltot	stot	vtot
sex	-.01	.15	.09	.02	-.09	-.06	-.06	-.09	-.04	-.18	-.08
paper2		.25	.27	.25	.11	-.02	.13	.14	.33	.09	.45
modpon			.56	.43	-.25	-.06	.10	.19	.59	.12	.27
modtol				.52	-.22	-.05	.05	.23	.64	.13	.32
mval					-.01	-.22	.20	.19	.60	.22	.33
denant						.04	.15	.15	.26	.15	.16
minval							-.00	.16	.34	-.09	-.01
mathv								.13	.39	.15	.30
mathin									.54	.12	.24
logtot										.22	.46
spatot											.37
vertot											1.00

(b) Varimax rotated factor analysis (2 factors, eigenvalues 2.16 and 0.89 explaining 59.4% and 24.4% of variance respectively) of (a) omitting logtot

	Factor 1	Factor 2
sex	-.19	.15
paper2	.44 *	.22
modpon	.22	.65 *
modtol	.25	.71 *
mval	.39 *	.53 *
denant	.36 *	-.38 *
minval	.01	-.15
mathv	.38 *	-.00
mathin	.36 *	.11
spatot	.44 *	.03
vertot	.68 *	.20

1988

(a) Correlation matrix

	pap2	modp	modt	mval	den	minv	mv	mi	ltot	stot	vtot
sex	-.06	.11	.13	-.00	-.15	-.04	-.11	-.02	-.01	-.15	-.04
paper2		.13	.12	.17	.11	.05	.18	.13	.24	.11	.30
modpon			.49	.36	-.17	-.02	.11	.22	.55	.10	.24
modtol				.46	-.16	.01	.10	.30	.64	.18	.32
mval					.04	-.16	.20	.23	.58	.18	.32
denant						.15	.18	.19	.37	.12	.10
minval							.04	.17	.41	.08	.06
mathv								.16	.42	.18	.24
mathin									.58	.10	.24
logtot										.27	.41
spatot											.37
vertot											1.00

(b) Varimax rotated factor analysis (2 factors, eigenvalues 1.93 and 0.85 explaining 59.3% and 26.1% of variance respectively) of (a) omitting logtot

	Factor 1		Factor 2	
sex	.03		-.03	
paper2	.30	*	.23	
modpon	.57	*	-.24	
modtol	.68	*	-.24	
mval	.61	*	-.05	
denant	.00		.50	*
minval	.01		.25	
mathv	.29		.30	*
mathin	.40	*	.19	
spatot	.33	*	.29	
vertot	.55	*	.26	

1989

(a) Correlation matrix

	pap2	modp	modt	mval	den	minv	mv	mi	ltot	mtot	vtot
sex	-.06	.02	.02	.03	-.08	-.08	-.15	-.04	-.07	-.33	-.10
paper2		.26	.26	.32	.12	-.01	.15	.20	.33	.32	.48
modpon			.51	.46	-.10	.03	.22	.26	.60	.28	.31
modtol				.50	-.17	.00	.20	.27	.61	.31	.31
mval					.07	-.07	.24	.27	.63	.33	.34
denant						.13	.12	.18	.37	.24	.20
minval							.09	.21	.46	.16	.06
mathv								.14	.47	.42	.32
mathin									.58	.27	.28
logtot										.52	.47
mathot											.50

(b) Varimax rotated factor analysis (2 factors, eigenvalues 2.65 and 0.85 explaining 64.8% and 20.8% of variance respectively) of (a) omitting logtot

	Factor 1	Factor 2
sex	-.02	-.35 *
paper2	.46 *	.23
modpon	.65 *	-.09
modtol	.70 *	-.14
mval	.67 *	-.00
denant	-.02	.47 *
minval	-.01	.26
mathv	.35 *	.32 *
mathin	.38 *	.22
mathot	.49 *	.55 *
vertot	.55 *	.40 *

Starting with the raw correlations, it is clearly seen that the logic, spatial and verbal totals are always highly correlated, and that the close connection between logical ability and language use more generally is also revealed by the correlations with Paper 2. Interestingly, the invalid plurative principle MINVAL is consistently uncorrelated with verbal or language ability.

The usual result of the factor analyses is to produce one factor loading heavily on the formally valid principles, and usually also on the verbal and spatial tests, while the second factor loads on DENANT, MATHV, and to a lesser extent MINVAL and other variables. The 1987 factor pattern is unusual in having the valid item factor come second. In most cases the non-formal logic principles and the other parts of the test (verbal and spatial or mathematical) load reasonably highly on both factors; sex is usually not featuring on either factor though it gets a hold on the invalid factor in 1986 and 1989.

Conclusion

The main pedagogical interest of these data has already been expressed: performance on everyday reasoning tasks is grossly inadequate. It is bad wherever it is tested, but the standards revealed in table 4 are generally lower than Ennis' results from US secondary schools. The little evidence that exists (summarized in Brandon and Sirbratthie [4]) suggests that this disadvantage is not confined to the test format employed here, but extends also to more discursive tests of aspects of critical thinking. Pedagogically, it is not of the greatest urgency to explore the factorial structure of

actual performance (though this might help in suggesting remedies); what matters is to find ways to improve that performance. This may well, as it usually does elsewhere, involve the teaching of new techniques, new ways of handling the information given.

This paper is not, however, intended to argue for or to suggest such remedial action. Its point is simply to record the situation with respect to a few aspects of logical reasoning as it is in many Caribbean schools at present.

Footnotes

1. Thus, to take but one example, if it were required that mastery of the valid principle to be labelled MODTOL were to involve recognizing also that the structurally similar principle DENANT is invalid, the percentage mastery in 1989 would drop from 44% to 2.3%; with the easier principle MODPON there would be a drop from 69% to 4%.

2. See Norris [11] for some careful discussion of the problems involved in characterizing the processes actually used by people in performing reasoning tasks, Johnson-Laird [8] for a stimulating psychological review that argues against the use of logical principles or rules, and Brandon [2] for a few comments on this matter in the context of the present investgiation.

References

[1] BRANDON, E.P., 1985, "On What isn't Learned in School," Thinking, 5, 22-28.

[2] -------, 1987a, "Deductive Reasoning Ability, Error, and Education," in F.H. van Eemeren, R. Grootendorst, J.A. Blair, and C.A. Willard, (eds.), Proceedings of the First International Conference on Argumentation 3A Argumentation: Perspectives and Approaches, Dordrecht: Foris, pp. 151-161.

[3] -------, 1987b, Do Teachers Care About Truth? London: Allen and Unwin.

[4] BRANDON, E.P. and SIRBRATTHIE, N., to appear, "Logical Reasoning as a Curriculum Area in Schools" in a volume edited by D. Craig.

[5] ENNIS, R.H. and PAULUS, D.H., 1965, Critical Thinking Readiness in Grades 1-12 (Phase I, Deductive Reasoning in Adolescence). Cornell Critical Thinking Project (ERIC Document Reproduction Service No. ED 003 818).

[6] GEACH, P.T., 1976, Reason and Argument. Oxford: Basil Blackwell.

[7] HODGES, W., 1977, Logic. Harmondsworth: Penguin.

[8] JOHNSON-LAIRD, P.N., 1983, Mental Models. Cambridge: Cambridge University Press.

[9] NOLAN, C.A., 1984, An Investigation into the Logical Reasoning Competence of Selected Groups of Students in a Comprehensive High School in Jamaica. Unpublished B.Ed. study, University of the West Indies, Mona.

[10] NOLAN, C.A. and BRANDON, E.P., 1986, "Conditional reasoning in Jamaica," paper given to the Conference on Thinking, Harvard, 1984 (ERIC Document Reproduction Service No. SO 016 755).

[11] NORRIS, S.P., 1985, "Review article - the choice of standard conditions in defining critical thinking competence," Educational Theory, 35, 97-107.

Appendices: Item Analyses

Note: The figure given in the Diff(iculty) column for each principle is the average difficulty for the items included in the principle.
Where appropriate, suggestive items are labelled as follows: q12!; while symbolic items are labelled with an "x", as q24x.

Appendix 1
Item analysis 1985

	Y	N	M	Omit	Correct	Diff	Disc	Item s.d.	Item/scale corr.
modpon						.64			
q3	346	18	239	19	Y	.55	.18	.49	.17
q12!	473	85	37	27	Y	.76	.35	.42	.36
q16	66	417	82	57	N	.67	.52	.47	.46
q24x	466	12	31	113	Y	.74	.66	.43	.62
q29	365	21	96	140	Y	.58	.70	.49	.57
q36	326	13	96	187	Y	.52	.76	.49	.59
modtol						.55			
q2	19	520	67	16	N	.83	.22	.37	.26
q10	118	273	116	115	N	.43	.34	.49	.29
q17x	117	274	68	163	N	.44	.50	.49	.41
q23	318	98	87	119	Y	.51	.59	.49	.47
q28	23	374	59	166	N	.60	.79	.48	.61
q32!	96	290	41	195	N	.46	.74	.49	.55
hypsyl						.72			
q1	532	34	48	8	Y	.85	.18	.35	.23
q8	534	17	49	22	Y	.85	.20	.34	.27
q13x	359	144	55	46	Y	.57	.44	.49	.35
q21	502	8	33	79	Y	.80	.48	.39	.53
q25!	419	68	30	105	Y	.67	.66	.46	.58
q34	363	26	50	183	Y	.58	.77	.49	.61
dencon						.63			
q4!	61	476	53	32	N	.76	.32	.42	.28
q7	21	561	32	8	N	.90	.15	.29	.23
q14	409	112	55	46	Y	.65	.47	.47	.41
q20x	58	301	89	174	N	.48	.50	.49	.42
q26	139	231	76	176	N	.37	.53	.48	.41
q35	16	404	17	185	N	.64	.86	.47	.68
affcon						.20			
q5	364	34	190	34	M	.30	.29	.46	.24
q9!	380	102	96	44	M	.15	.16	.36	.20
q18	118	355	87	62	M	.13	.14	.34	.19
q22x	377	30	76	139	M	.12	.14	.32	.20
q27	193	44	251	134	M	.40	.58	.49	.45
q31	311	37	94	180	M	.15	.13	.35	.13

qafcon						.26			
q6	418	52	124	28	M	.19	.14	.39	.17
q11	281	51	266	24	M	.42	.44	.49	.35
q15x	234	160	129	99	M	.20	.25	.40	.26
q19	302	75	171	74	M	.27	.38	.44	.37
q30	41	209	215	157	M	.34	.57	.47	.48
q33!	284	76	78	184	M	.12	.29	.33	.34

Scale standard deviation = 6.32; Cronbach alpha for scale = 0.85.

Appendix 2
Item analysis 1986

	Y	N	M	Omit	Correct	Diff	Disc	Item s.d.	Item/scale corr.
modtol						.70			
q5	250	97	105	21	Y	.53	.45	.50	.34
q10	19	434	17	2	N	.92	.11	.27	.18
q15	29	353	84	6	N	.75	.30	.43	.24
q29	322	35	79	36	Y	.68	.32	.47	.30
q33	307	66	60	39	Y	.65	.44	.48	.38
q36	48	310	62	52	N	.66	.28	.47	.24
mval						.77			
q1	271	63	132	6	Y	.57	.41	.49	.31
q8	30	413	20	9	N	.88	.24	.33	.29
q13	47	389	30	6	N	.82	.26	.38	.25
q21	309	79	59	25	Y	.65	.47	.48	.36
q25	419	9	29	15	Y	.89	.18	.32	.30
q34	8	393	27	44	N	.83	.28	.37	.34
denant						.26			
q3	222	121	121	8	M	.26	.31	.44	.34
q7	261	77	117	17	M	.25	.09	.43	.10
q12	36	340	90	6	M	.19	.13	.39	.14
q17	243	83	137	9	M	.29	.31	.45	.27
q20	19	326	120	7	M	.25	.30	.44	.27
q28	239	54	156	23	M	.33	.39	.47	.35
minval						.26			
q6	244	108	112	9	M	.24	.34	.43	.35
q11	206	138	115	13	M	.24	.35	.43	.34
q18	256	74	139	3	M	.29	.31	.46	.32
q23	235	82	141	14	M	.30	.35	.46	.37
q26	273	47	125	27	M	.26	.31	.44	.36
q31	276	45	118	33	M	.25	.39	.43	.38
mathv						.61			
q9	383	45	38	6	Y	.81	.24	.39	.25
q22	157	291	11	13	N	.62	.29	.49	.29
q27	194	195	28	55	N	.41	.30	.49	.27
mathin						.68			
q24	45	23	394	10	M	.83	.35	.37	.37
q30	11	66	369	26	M	.78	.35	.41	.39
q35	132	91	197	52	M	.42	.46	.49	.37
relv						.75			
q4	89	315	61	7	N	.67	.46	.47	.34
q14	421	14	26	11	Y	.89	.22	.31	.28
q19	328	40	100	4	Y	.69	.43	.46	.36
reli						.48			
q2	173	38	248	13	M	.53	.28	.50	.22
q16	66	41	363	2	M	.77	.45	.42	.43
q32	349	16	64	43	M	.14	.16	.34	.18

Scale standard deviation = 4.69; Cronbach alpha for scale = 0.71.

Appendix 3
Item analysis 1987

	Y	N	M	Omit	Correct	Diff	Disc	Item s.d.	Item/scale corr.
modpon						.78			
q2	250	10	99	2	Y	.69	.39	.46	.33
q4	270	72	14	5	Y	.75	.38	.43	.35
q14	34	278	43	6	N	.77	.37	.42	.36
q16	326	7	25	3	Y	.90	.25	.30	.34
q19	295	12	49	5	Y	.82	.31	.39	.34
q32	271	11	52	27	Y	.75	.34	.43	.35
modtol						.63			
q5	147	104	78	32	Y	.41	.48	.49	.36
q10	49	256	53	3	N	.71	.33	.45	.27
q15	19	264	68	10	N	.73	.42	.44	.36
q29	253	34	53	21	Y	.70	.35	.46	.32
q33	219	52	55	35	Y	.61	.59	.49	.46
q36	47	217	52	45	N	.60	.49	.49	.40
mval						.76			
q1	190	60	107	4	Y	.53	.41	.50	.31
q8	16	320	20	5	N	.89	.27	.32	.31
q13	40	291	24	6	N	.81	.22	.40	.25
q21	221	56	60	24	Y	.61	.45	.49	.36
q25	326	5	23	7	Y	.90	.19	.30	.28
q34	10	286	25	40	N	.79	.37	.41	.38
denant						.28			
q3	162	85	108	6	M	.30	.25	.46	.23
q7	198	87	65	11	M	.18	.04	.38	.03
q12	30	252	76	3	M	.21	-.06	.41	.04
q17	190	49	113	9	M	.31	.19	.46	.18
q20	12	227	114	8	M	.32	.22	.46	.18
q28	174	41	128	18	M	.35	.33	.48	.29
minval						.29			
q6	160	97	100	4	M	.28	.13	.45	.17
q11	167	94	93	7	M	.26	.26	.44	.26
q18	173	69	109	10	M	.30	.19	.46	.17
q23	142	82	123	14	M	.34	.32	.47	.28
q26	192	44	115	10	M	.32	.22	.47	.21
q31	192	59	87	23	M	.24	.23	.43	.25
mathv						.54			
q9	262	40	48	11	Y	.73	.32	.45	.27
q22	154	182	19	6	N	.50	.30	.50	.28
q27	165	146	25	25	N	.40	.19	.49	.19
mathin						.69			
q24	31	28	292	10	M	.81	.35	.39	.36
q30	10	55	281	15	M	.78	.36	.42	.36
q35	91	53	169	48	M	.47	.55	.50	.41

Scale standard deviation = 4.51; Cronbach alpha for scale = 0.67.

Appendix 4
Item analysis 1988

	Y	N	M	Omit	Correct	Diff	Disc	Item s.d.	Item/scale corr.
modpon						.80			
q2	453	13	126	1	Y	.76	.23	.43	.24
q4	433	108	41	11	Y	.73	.32	.44	.27
q14	47	464	79	3	N	.78	.34	.41	.34
q16	556	9	24	4	Y	.94	.13	.24	.25
q19	498	21	68	6	Y	.84	.23	.37	.28
q32	446	19	91	37	Y	.75	.40	.43	.37
modtol						.66			
q5	282	166	108	37	Y	.48	.49	.50	.36
q10	62	433	89	9	N	.73	.28	.44	.25
q15	33	453	91	16	N	.76	.31	.43	.30
q29	404	54	101	34	Y	.68	.44	.47	.36
q33	390	74	61	68	Y	.66	.56	.47	.46
q36	60	383	77	73	N	.65	.41	.48	.37
mval						.74			
q1	311	85	184	13	Y	.52	.44	.50	.34
q8	34	512	24	23	N	.86	.22	.34	.27
q13	81	475	31	6	N	.80	.26	.40	.25
q21	352	96	103	42	Y	.59	.44	.49	.34
q25	524	21	38	10	Y	.88	.19	.32	.27
q34	9	481	44	59	N	.81	.32	.39	.34
denant						.26			
q3	254	152	174	13	M	.29	.30	.46	.28
q7	301	153	112	27	M	.19	.11	.39	.12
q12	48	431	105	9	M	.18	.08	.38	.10
q17	304	101	176	12	M	.30	.22	.48	.23
q20	21	405	159	8	M	.27	.22	.44	.23
q28	310	70	186	27	M	.31	.28	.46	.28
minval						.29			
q6	259	164	159	11	M	.27	.31	.44	.30
q11	278	153	146	16	M	.25	.26	.43	.27
q18	276	106	200	11	M	.33	.20	.47	.20
q23	258	139	179	17	M	.30	.24	.46	.24
q26	309	61	198	25	M	.33	.26	.47	.22
q31	327	76	150	40	M	.25	.35	.44	.34
mathv						.55			
q9	451	69	58	15	Y	.76	.32	.43	.26
q22	267	303	11	12	N	.51	.29	.50	.27
q27	251	223	40	79	N	.38	.32	.48	.24
mathin						.63			
q24	59	56	465	13	M	.78	.44	.41	.39
q30	22	76	468	27	M	.79	.38	.41	.39
q35	174	89	249	81	M	.42	.51	.49	.42

Scale standard deviation = 4.57; Cronbach alpha for scale = 0.69.

Appendix 5
Item analysis 1989

	Y	N	M	Omit	Correct	Diff	Disc	Item s.d.	Item/scale corr.
modpon						.81			
q2	482	11	126	3	Y	.77	.29	.42	.28
q4	487	93	33	9	Y	.78	.25	.41	.25
q14	44	503	63	12	N	.81	.34	.39	.34
q16	587	7	19	9	Y	.94	.15	.23	.31
q19	529	14	63	16	Y	.85	.27	.36	.34
q32	447	30	85	60	Y	.72	.53	.45	.47
modtol						.67			
q5	316	143	114	49	Y	.51	.43	.50	.33
q10	62	454	96	10	N	.73	.30	.44	.26
q15	26	472	98	26	N	.76	.27	.43	.27
q29	430	44	109	39	Y	.69	.37	.46	.36
q33	407	65	86	64	Y	.65	.56	.48	.45
q36	60	412	64	86	N	.66	.49	.47	.41
mval						.75			
q1	330	93	181	18	Y	.53	.41	.50	.32
q8	18	554	34	16	N	.89	.21	.31	.25
q13	84	490	35	13	N	.79	.25	.41	.26
q21	399	79	86	58	Y	.64	.44	.48	.35
q25	532	18	59	13	Y	.86	.26	.35	.36
q34	12	497	41	72	N	.80	.46	.40	.46
denant						.26			
q3	277	155	177	13	M	.28	.36	.45	.33
q7	329	150	115	28	M	.18	.11	.39	.10
q12	39	449	119	15	M	.19	.07	.39	.08
q17	317	89	195	21	M	.31	.27	.46	.24
q20	22	398	186	16	M	.30	.29	.46	.27
q28	327	81	184	30	M	.30	.33	.46	.30
minval						.32			
q6	246	171	189	16	M	.30	.29	.46	.28
q11	252	158	188	24	M	.30	.35	.46	.32
q18	269	111	221	21	M	.36	.31	.48	.30
q23	266	132	199	25	M	.32	.31	.47	.31
q26	322	67	207	26	M	.33	.39	.47	.35
q31	311	67	207	26	M	.28	.31	.45	.31
mathv						.56			
q9	469	67	59	27	Y	.75	.33	.43	.30
q22	245	326	24	27	N	.52	.45	.50	.35
q27	234	250	50	88	N	.40	.37	.49	.30
mathin						.65			
q24	59	74	474	15	M	.76	.41	.43	.39
q30	17	111	462	32	M	.74	.41	.44	.41
q35	165	89	277	91	M	.45	.55	.50	.42

Scale standard deviation = 5.01; Cronbach alpha for scale = 0.74.